

IN THE UNITED STATES DISTRICT COURT  
FOR THE DISTRICT OF MASSACHUSETTS

ANALOG DEVICES, INC. and HITTITE  
MICROWAVE LLC,

Plaintiffs,

v.

MACOM TECHNOLOGY SOLUTIONS  
HOLDINGS, INC. and MACOM  
TECHNOLOGY SOLUTIONS INC.,

Defendants.

Civil Action No. 1:18-cv-11028-GAO

**DECLARATION OF DR. MARK HORENSTEIN**

I, MARK N. HORENSTEIN, Ph.D., hereby declare as follows:

1. My name is Mark Horenstein, and I am a Professor of Electrical Engineering at Boston University. I have over 40 years of experience in electromagnetics, electric power systems, electronic design, and integrated circuits.

2. I have been retained by Analog Devices, Inc. and Hittite Microwave LLC (collectively, "Analog"), the plaintiffs in the above-captioned action, to consult as an expert on some of the technology at issue in this lawsuit.

3. I have personal knowledge of, and expert opinions regarding, the facts set forth in this declaration. If called upon as a witness, I could and would testify competently to the statements made in this declaration.

## **I. QUALIFICATIONS**

4. I received my Ph.D. from the Massachusetts Institute of Technology in 1978, where I studied in the Electric Power Systems Engineering Laboratory. As a graduate student, I designed electronic circuits as part of my dissertation on high-voltage insulation. Also as a graduate student, I served as the Graduate Teaching Assistant for courses in electronics and circuit design.

5. I also attended MIT as an undergraduate, where I obtained a bachelor's degree in Electrical Engineering in 1973. I completed my master's degree in Electrical Engineering at the University of California at Berkeley in 1975, working in the area of solid-state devices and integrated circuit devices.

6. After completing my Ph.D., I worked for one year as a research scientist in the High-Voltage Pulsed-Power Division at Spire Corporation. At Spire, I performed such tasks as power supply design, insulation testing, and the use of pulsed power as a tool for annealing semiconductor wafers after ion implantation.

7. In 1979, I joined the faculty of Boston University as an Assistant Professor of Electrical and Computer Engineering. I presently serve as a Professor in the Department of Electrical and Computer Engineering. During my time at Boston University, I also have served in administrative roles, including as the Associate Dean for Graduate Programs and Research (Engineering), and the Associate Chair for Undergraduate Programs (Electrical and Computer Engineering Department).

8. I have consulted with companies in the areas of electronic circuits. In the 1990s, I designed two circuit-based devices that became commercial products. I have also designed for

commercial purposes a circuit used to actuate micro-electromechanical devices made via surface micromachining of silicon wafers.

9. At Boston University, I teach courses on electric circuits, analog electronics, power electronics, electromagnetics, including *rf* systems, robotics, and engineering design.

10. I am the author of a textbook on electronic circuit design, including semiconductor layout and device physics, entitled, *Microelectronic Circuits and Devices* (first and second editions, Pearson Prentice-Hall, 1990, 1996). Over the years, this textbook has been used in undergraduate courses in electronics at over 50 schools and colleges, and is still in use today at some universities, including Boston University. It has also served, and still does serve, as a reference text by instructors of electronics at numerous academic institutions.

11. I am a named inventor on five United States patents.

12. My education and work background, list of publications, and list of my testimony at previous depositions and trial are set forth in my curriculum vitae attached as Exhibit A.

13. I am being compensated for my time spent in connection with this case at a rate of \$325 per hour. My compensation does not depend on the opinions that I may form or on the outcome of this case.

## **II. MATERIALS REVIEWED**

14. The opinions herein are based on my personal knowledge, education, and expertise. In preparing this declaration, in addition to the items mentioned in this report, I reviewed and considered at least the items listed in Exhibit B.

### III. ANALOG'S '752 PATENT

15. United States Patent No. 9,425,752 (the "'752 patent") is titled, "Distributed Amplifier With Improved Stabilization." The '752 patent discloses improvements over a traditional distributed amplifier. A copy of the '752 patent is attached as Exhibit C.

16. A basic building block of an amplifier is a transistor. A single transistor together with other passive circuit components can perform an amplifying function, or multiple transistors can be combined into more complex amplifier circuits. Transistors can also provide other functions within circuits. There are different types of transistors, but the type used in the '752 patent is known as a MOSFET (metal-oxide semiconductor field effect transistor) , or sometimes just FET (field effect transistor). An FET has an input terminal called the *gate* and two other terminals called the *source* and the *drain*. The '752 patent uses a type of multi-transistor amplifier configuration known as a cascode amplifier, and in some implementations, uses multiple cascode amplifiers with three FETs arranged in a stack (a "triple stack amplifier"). To enhance stability in distributed amplifiers so that they provide a consistent and expected output across all the frequencies, the patent also discloses that feedback networks "may be connected between the drain and gate electrodes of one or more of the common-gate transistors." ('752 patent, 6:17-26.) The patent further discloses other ways of stabilizing the amplifier, including the use of a resistor and a capacitor connected in series between the gate of one or two of the FETs in the stack and a ground node. (See e.g. claim 16.)

### IV. LEGAL STANDARDS

17. Counsel for the plaintiffs has informed me of some of the relevant legal standards to be applied in this case. I understand, for example, that a patent infringement determination is made by comparing the patent claim at issue to the accused products. I also understand that

patent infringement is shown by proving that the accused device has each and every claim limitation of the asserted claim, either literally or under the doctrine of equivalents.

18. I understand that under the doctrine of equivalents, a limitation in the accused product is equivalent to a claim limitation if the differences between the two are insubstantial. I also understand that one of the ways insubstantiality may be found is by determining whether a particular element of the accused device performs substantially the same function, in substantially the same way, to obtain substantially the same result as the claim limitation at issue.

19. I understand that dependent claims include each and every limitation of the claim or claims on which they depend, and that to show infringement of a dependent claim, in addition to showing that the accused device meets each and every limitation recited in the dependent claim, plaintiffs must show that the accused device meets each and every limitation of the claims on which the dependent claim depends. Where I discuss infringement of dependent claims, I incorporate into each such dependent claim my analysis and discussion with respect to the claim or claims upon which each such dependent claim depends.

20. As the claims have not yet been construed by the Court, I will interpret the claim language here according to the plain and ordinary meaning that it would have had to a person having ordinary skill in the art at the time of the invention. Should the Court later construe any of the patent claims in ways that conflict with my interpretation, I will supplement this declaration as necessary to address the infringement analysis pursuant to the Court's constructions.

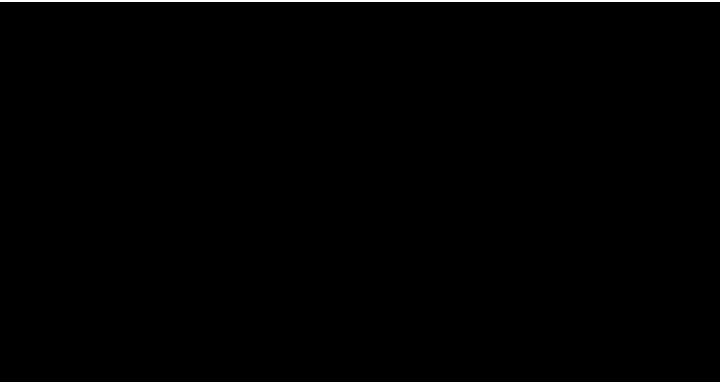



## **V. MACOM'S INFRINGEMENT OF THE '752 PATENT**


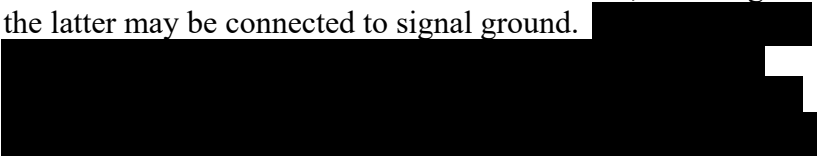
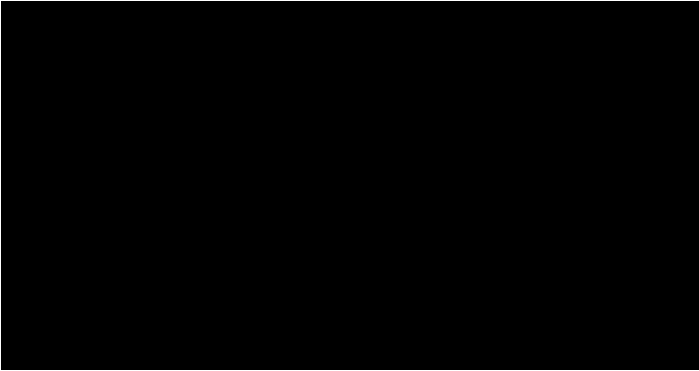

21. In preparing this declaration, I have studied photographs of the MACOM MAAP-011247 power amplifier. These photographs were provided to me by counsel for plaintiffs and

are attached as Exhibits D, E, F, G, and H . I have also studied data sheets for the MAAP-011247 and MAAP-011247-DIE, attached as Exhibits I and J respectively.



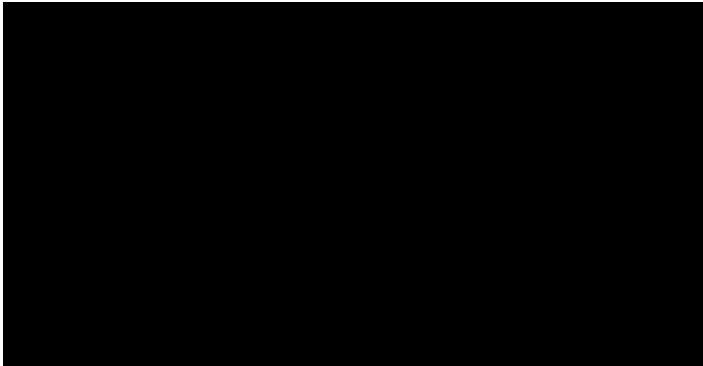

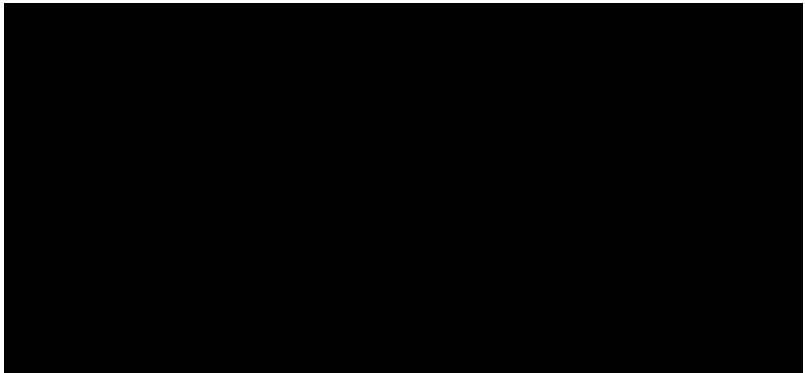

22. From my review of these data sheets, photographs, and the various components pictured therein, it is my opinion that the MACOM MAAP-011247 and MAAP-011247-DIE power amplifiers (collectively, “MAAP-011247”) each infringe at least claims 15, 16, and 17 of the ‘752 patent.

23. I have provided my infringement analysis and opinions in the claim charts below.

U.S. Patent No. 9,425,752	MAAP-011247 Power Amplifier
15. A distributed amplifier comprising:	The MAAP-011247 amplifier is a type of distributed power amplifier. Its data sheet describes the device as a “2 W distributed power amplifier. . .” (Ex. I at 1; <i>see also</i> Ex. J at 1.)
an input transmission line;	 
an output transmission line;	 

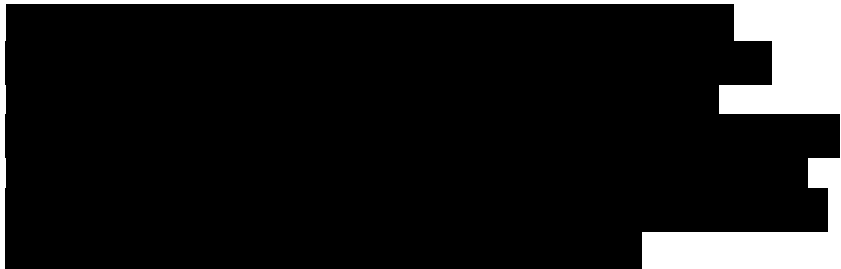
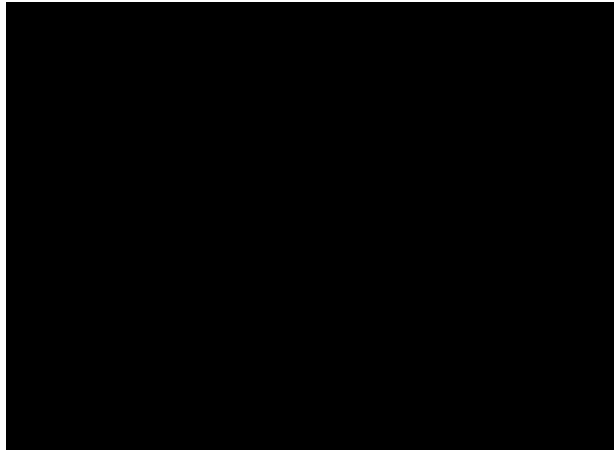
<p>and a plurality of cascode amplifiers each coupled between the input transmission line and the output transmission line,</p>	 <p>A cascode amplifier is generally speaking a vertically oriented stack of two or more transistors, in this case MOSFETs (“FETs” for short), where the gate of the bottom transistor may be driven by a signal, and the output may be taken from the drain of the uppermost MOSFET. The drain of the lower MOSFET may be connected to the source of the MOSFET above it, and the gate of the latter may be connected to signal ground.</p> 
<p>wherein a first cascode amplifier of the plurality of cascode amplifiers comprises: three or more field effect transistors (FETs) arranged in a stack, wherein the three or more FETs comprises a first FET, a second FET, and a third FET,</p>	 



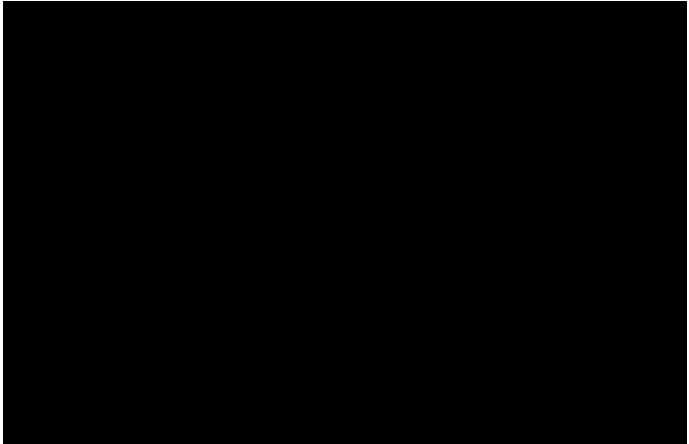

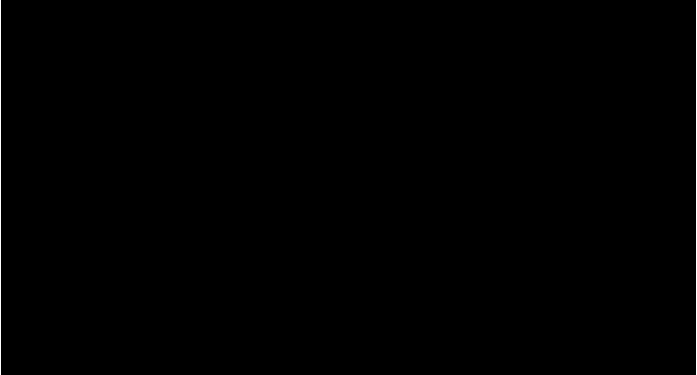

<p>wherein the first FET includes a gate coupled to the input transmission line,</p>	 
<p>wherein the second FET is positioned between the first FET and the third FET in the stack,</p>	 
<p>and wherein the third FET includes a drain coupled to the output transmission line;</p>	 



and a first stabilization circuit coupled to a gate of the third FET, wherein the first stabilization circuit comprises a first resistor and a first capacitor electrically connected in series,



wherein the first FET is configured to generate an amplified signal by amplifying an input signal received at the gate of the first FET from the input transmission line, wherein the first FET is further configured to provide the amplified signal to the output transmission line through the second FET, from a source of the second FET to a drain of the second FET, and through the third FET, from a source of the third FET to the drain of the third FET.

<p>16. The distributed amplifier of claim 15, wherein the first resistor and the first capacitor are electrically connected in series between the gate of the third FET and a ground node.</p>	 
<p>17. The distributed amplifier of claim 15, further comprising a second stabilization circuit coupled to a gate of the second FET.</p>	 

**VI. CERTAIN FEATURES OF MACOM'S MAAP-011247 AMPLIFIER CHIP**

24. I have been informed by counsel that Analog is asserting in the litigation that certain of its trade secret designs for MMIC amplifiers were misappropriated by MACOM. I have been informed that Analog is asserting in the litigation that at least the following design features for MMIC distributed power amplifiers are its trade secrets:

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

25. I am not a lawyer, and I form no opinion here as to whether these design features are in fact trade secrets under trade secret law. However, from my review of the photographs of the MACOM MAAP-011247 power amplifier, it is my opinion that these design features are present in the MACOM MAAP-011247 power amplifier.

26. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

27. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

28. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

## **VII. CONCLUSION**

I declare under penalties of perjury under the laws of the United States that the foregoing facts are true, and that the foregoing opinions are my own.

Executed this 18th day of June, 2018.

A handwritten signature in blue ink, appearing to read "Mark N. Horenstein", is written over a horizontal line.

Mark N. Horenstein, Ph.D.



**CERTIFICATE OF SERVICE**

I hereby certify that this document filed through the ECF system will be sent electronically to the registered participants as identified on the Notice of Electronic Filing on June 29, 2018.

/s/ Steven M. Bauer

Steven M. Bauer